

A REVIEW OF THE PLANTHOPPER GENUS *NILAPARVATA* (HEMIPTERA: DELPHACIDAE) IN THE NEW WORLD¹

Charles R. Bartlett²

ABSTRACT: The delphacid genus *Nilaparvata*, previously recorded in the New World only from Puerto Rico and Nicaragua, is here reported from a variety of localities from Wisconsin and New Hampshire in the United States, south to Bolivia and Paraguay. *Euides gerhardi* is here transferred to *Nilaparvata*, and a revised key and diagnoses for the four New World species are provided.

KEY WORDS: Planthoppers, Homoptera, Auchenorrhyncha, Fulgoromorpha, Fulgoroidea, *Euides*

The delphacid genus *Nilaparvata* Distant, 1906, consists of 18 species, with most occurring in the Oriental, Australian and Afrotropical regions (Claridge and Morgan 1987 list 16 species, omitting *N. serrata* Caldwell, plus *N. terracefrons* Guo and Liang was described by Guo et al., 2005). Three species have been previously recorded from the New World, with a fourth species here transferred to *Nilaparvata* (for a total of 19 species). *Nilaparvata* is an extremely important genus economically, with one of its members, *N. lugens* (Stål), a major pest of rice (*Oryza sativa* L., Poaceae, Oryzeae; e.g., Claridge and Wilson 1982, Hill 1983, Wilson and Claridge 1985, 1991; Suzuki 2004). Two other species, *N. bakeri* (Muir) and *N. muiri* China, are also found in rice (Wilson and Claridge 1991). The New World species, however, have not been reported from rice (Wilson and O'Brien 1987, Wilson and Claridge 1991), and the only host associations reported are sugarcane (*Saccharum officinarum* L., Poaceae: Andropogoneae) and maljillo grass (*Panicum molle* Swartz, Poaceae: Paniceae) for *N. wolcottii* Muir and Giffard (Muir and Giffard 1924, Wolcott 1936, Wilson and O'Brien 1987). Old World *Nilaparvata* species are also known to feed on *Leersia* (Poaceae: Oryzeae) (Sogawa and Kilin 1984, Sogawa et al., 1984, Claridge and Morgan 1987, Wilson et al., 1994).

The published records of all three previously reported New World species are limited to Puerto Rico (Muir and Giffard 1924, Caldwell and Martorell 1951), except that *N. serrata* is reported from Nicaragua (Maes and O'Brien 1988). This investigation was initiated after discovering specimens of *Nilaparvata* in light samples from Hills County, New Hampshire. Here the New World species are reviewed, and *Euides gerhardi* (Metcalf) is transferred to *Nilaparvata*. A species key, diagnoses, and all available specimen records are presented for New World *Nilaparvata*.

¹ Received on March 28, 2006. Accepted on May 23, 2006.

² Department of Entomology and Wildlife Ecology, University of Delaware, 250 Townsend Hall, 531 S. College Ave., Newark, Delaware 19716-2130 U.S.A. E-mail: 02542@udel.edu.

METHODS

The morphological terminology follows Asche (1985), but for descriptive purposes the parameres will be referred to as having a proximal "basal angle," and distal "inner" and "outer angles" (*sensu* Metcalf 1949); and the more precise "segment X" will be used instead of "anal tube" (= "analrohr"). A total of 216 New World *Nilaparvata* specimens were examined (Table 1), plus the primary types of all described species.

Table 1. Number and distribution of New World *Nilaparvata* specimens examined. States of the U.S.A. are indicated by standard US Postal Service abbreviations.

Species	Gender		Distribution
	Males	Females	
<i>N. caldwelli</i>	9	0	USA: FL, NC; Belize; Puerto Rico; Hispaniola.
<i>N. gerhardi</i>	14	4	USA: IL, NH, NJ, NC, VA; ? Guatemala.
<i>N. serrata</i>	53	31	USA: FL; Mexico; Belize; Costa Rica; Puerto Rico; Cayman Islands; ? Bolivia.
<i>N. wolcottii</i>	44	28	USA: AZ, CA, CO, DE, FL, MD, NJ, UT; Mexico; Puerto Rico.
<i>N. spp.</i>	—	33	USA: CA, CT, FL, MD, NY, WI; Belize; Costa Rica; Guatemala; Panama; Paraguay; Cuba.
Total	120	96	

The collections from which specimens were examined are abbreviated as follows (collection abbreviations according to Arnett et al., 1993):

BMNH - British Museum (Natural History), London, England, U.K.

CSCA - California State Collection of Arthropods, California Department of Food and Agriculture, Sacramento, California, U.S.A.

DENH - University of New Hampshire, Department of Entomology, Durham, New Hampshire, U.S.A.

EMEC - Essig Museum of Entomology, Department of Entomological Sciences, University of California, Berkeley, California, U.S.A.

FSCA - Florida State Collection of Arthropods, Florida Department of Agriculture and Consumer Services, Division of Plant Industry, Museum of Entomology, Gainesville, Florida, U.S.A.

INBC - Instituto Nacional de Biodiversidad, Santo Domingo de Heredia, Costa Rica.

LOBC - Lois O'Brien Collection (Associated with California Academy of Sciences, CASC), Green Valley, Arizona, U.S.A.

- LSUC - Louisiana State University Insect Collection, Department of Entomology, Louisiana State University, Baton Rouge, Louisiana, U.S.A.
- NCSU - North Carolina State University, Department of Entomology, Raleigh, North Carolina, U.S.A.
- NYSM - New York State Museum, Biological Survey, Cultural Education Center, Albany, New York, U.S.A.
- SEMC - University of Kansas, Snow Entomological Museum, Lawrence, Kansas.
- UDCC - University of Delaware, Department of Entomology and Wildlife Ecology, Insect Reference Collection, Newark, Delaware, U.S.A.
- UKYC - University of Kentucky, Department of Biology Insect Collection, Louisville, Kentucky, U.S.A.
- USNM - US National Museum of Natural History, Smithsonian Institution, Washington, District of Columbia, U.S.A.
- VGC - Vince Golia Collection, associated with Archbold Biological Station Collection (ABSC), Lake Placid, Florida, U.S.A.

Species diagnoses are provided with reference to New World taxa. Lengths reported are averages ($n = 4$) and ranges of total body length (in mm), including wings for macropters. All observed specimens are reported, although female specimens are either tentatively identified, or reported as "undetermined females." Reported specimen data follows the format of the specimen label, with added notes in square brackets. Label information for primary types is quoted, with each line break indicated by "/" and each label separated by "//". All specimens are macropterous unless otherwise noted.

Photographs and measurements were taken using a Nikon SMZ-1500 Digital Imaging Workstation with Nikon DS-U1 digital Camera and Eclipse Net Imaging software (version 1.16.6). Scale bar in all figures represents 0.5 mm.

SYSTEMATIC ENTOMOLOGY

The genus *Nilaparvata* Distant, 1906 (type species by original designation *Nilaparvata greeni* Distant, 1906, junior synonym of *Delphax lugens* Stål, 1854) can be separated from all other Delphacini by the presence of teeth on the hind basitarsus (Fig. 1, see also Caldwell and Martorell 1951: 194). There are usually 1-3 teeth on the proximal half of the ventral margin of the basitarsus, at least in New World species. Four New World species of *Nilaparvata* were found in this survey, the three species previously placed in *Nilaparvata*, with the fourth determined to be *Euides gerhardi* (Metcalf, 1923), and hence this species is here transferred to *Nilaparvata*. Each of these species was found to be much more widely distributed than has been previously reported.

Among New World Delphacini, *Nilaparvata* are relatively large and robust, and of a pale to deep brown color with conspicuous facial carinae. Among New World genera, *Nilaparvata* most closely resembles *Pareuidella* Beamer, and

species currently, but doubtfully, placed in the Old World genus *Euides* Fieber. Ashe (1985) considered *Euides* as consisting of four Palearctic plus one Oriental species, with all New World species in *Euides* at that time *incertae sedis* (four additional species were moved to *Euides* by Bartlett and Deitz 2000); hence there is a need for a revision of *Euides*, and there are some difficulties in finding features that consistently separate *Nilaparvata* from New World "*Euides*" as currently defined.

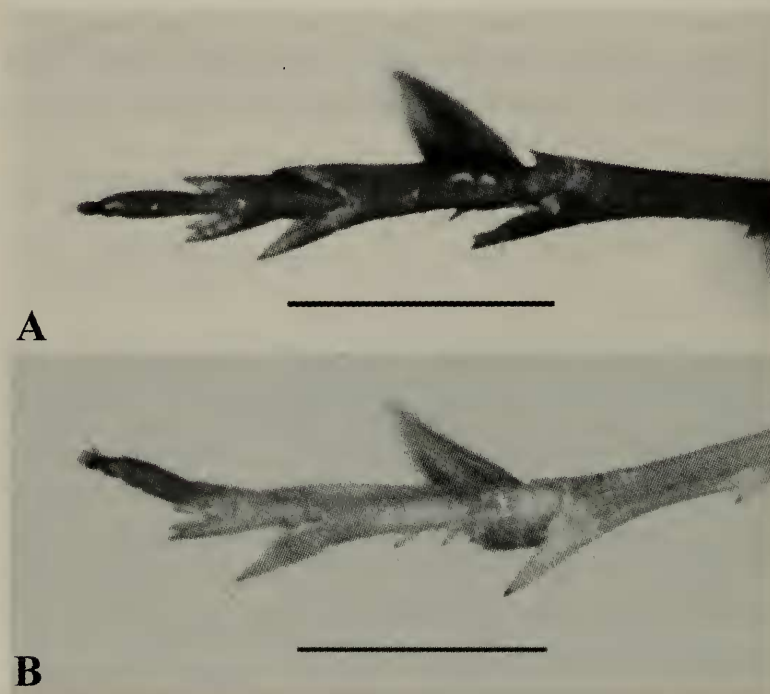


Figure 1. Basitarsus of species of *Nilaparvata*: A. *N. caldwelli* (from Florida) with a single tooth, and B. *Nilaparvata* sp. (female) from Belize with three teeth.

Nilaparvata can be recognized by the teeth on the basitarsus, a pair of processes on abdominal segment X (weakly developed in *N. wolcottii*) that are widely separated basally, two-branched parameres (*Pareuidella* and many "*Euides*" have multibranched parameres), and in having a weak genital diaphragm bearing poorly developed armature. All four New World *Nilaparvata* have a rounded tooth at opening of the pygofer at the ventral angles (*sensu* Metcalf 1949).

Nast (1984: 396) noted that the New and Old World species may belong in different genera, but since both New and Old World species share the teeth on the basitarsus, possess similar male genitalia, and are comparable in build and general color features, the New World species appear properly placed in *Nilaparvata*.

The New World *Nilaparvata* can be identified according to the following key based on male genitalia.

Key to the New World species of *Nilaparvata*

1. Aedeagus appearing bifid from base to apex (Fig. 2G), without subapical serrate flange, parameres (Fig. 2E) relatively narrow, apex acute and directed dorsolaterally*N. caldwelli*
- 1'. Aedeagus not appearing bifid, with serrate flange originating on right side; parameres relatively broad, apex blunt and directed laterally2
2. Segment X with long processes, approximated at base, originated subdorsally (Fig. 5G); parameres (Fig. 5F) in widest view broadly laterally projecting, lateral margin nearly truncate*N. serrata*
- 2'. Segment X with short processes or a pair of teeth, originating dorsally; parameres in widest view with dorsal margin broad and truncate, lateral margin acutely pointed, directed sublaterally.....3
3. Segment X processes very short (Fig. 6G), often reduced to teeth; originating somewhat medially from dorsolateral margin (Fig. 6D); parameres (Fig. 6F) in widest view with dorsal margin gradually sloped upwards to a dorsolaterally directed apex.....*N. wolcotti*
- 3'. Segment X processes longer, curved (Fig. 4G); originating from dorsolateral margin of segment X (Fig. 4D); parameres with dorsal margin subtruncate, lateral apex directed sublaterally*N. gerhardi*

Nilaparvata caldwelli Metcalf, 1955

Figures 2, 3A

Nilaparvata muiri Caldwell, 1951 (in Caldwell and Martorell 1951): 192-194 (nec. China, 1925).

Nilaparvata caldwelli Metcalf, 1955: 262 (replacement name for unavailable *N. muiri* Caldwell).

Nilaparvata bis Nast 1984: 396 (replacement name for unavailable *N. muiri* Caldwell).

Type material examined. "P.R. Acc. No. /Ponce, P.R. / 6-29-48 // Maldonado // *Nilaparvata* / Holotype / *muiri* [red paper] // JSCaldwell / Collection / 1959 // *Nilaparvata* ♂ / *muiri* / det 49 Holotype/ JSCaldwell" (♂ holotype, allotype ♀, and paratype ♂; USNM).

Diagnosis. Length ♂: 3.88 (3.75-4.00). This species is readily recognized by the aedeagus somewhat flattened and appearing bifid, and the relatively small and narrow parameres. The parameres have a weakly developed basal angle, a broadly toothlike inner angle, and an acutely dorsolaterally directed outer angle. The genital diaphragm is comparatively well-developed in *N. caldwelli*, bearing a thin, caudally directed, scooplike armature (Fig. 3A). Segment X bears a pair of

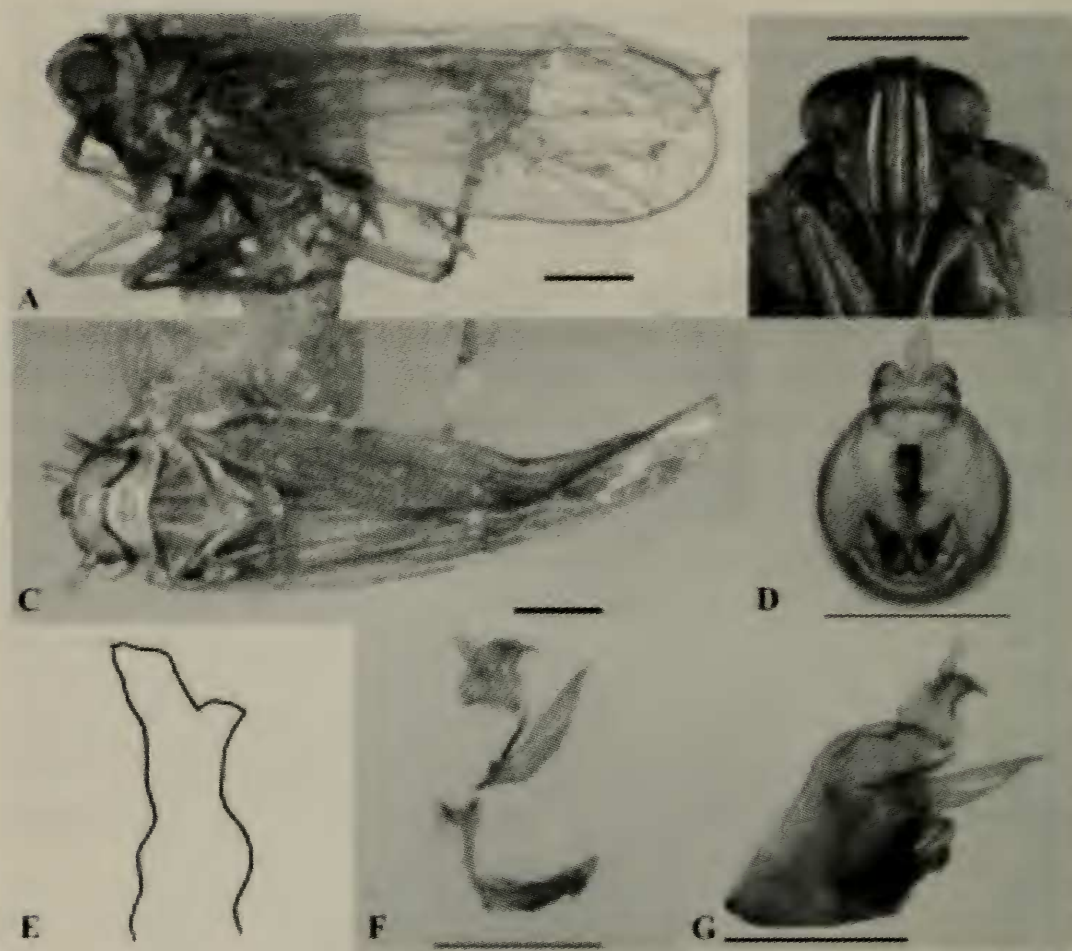


Figure 2. *Nilaparvata caldwelli*: A. lateral view, B. frons, C. dorsal view, D. pygofer, caudal view, E. left paramere, widest view, F. aedeagal complex with parameres and post genital segments, and G. pygofer, lateral view.

short, hooked processes from its dorsolateral margins. In color, this species is light brown with the prothorax somewhat paler between the lateral carinae. The median third of the mesonotum is faintly paler, suggesting a median vitta. Carinae on frons conspicuous, slightly paler than frons. Wings indistinctly infuscate, with a poorly developed darkened area at the end of the claval suture.

Remarks. The bifid appearing aedeagus, narrow parameres and relatively well-developed genital diaphragm make *N. caldwelli* distinctive among the New World species. Reports of this species from Africa need confirmation.

Distribution. USA: Florida, North Carolina; Belize, Puerto Rico and Hispaniola; also reported Senegal (Fennah 1961) and Sudan (Linnavuori 1973).

Specimens Examined. USA: NORTH CAROLINA: Bladen Co., White Lake @White Lake Campground, 15-IX-1995, C. R. Bartlett (1♂, UDCC). FLORIDA: Palm Beach Co., Lake Worth, Geneva Lakes Court, June 1, 2003, V. Golia, Black light (1♂, VGC) same July 25, 2003 (1♂, VGC). BELIZE (as British

Honduras): Rio Grande, June 1932 [♂ Light trap], J. J. White, (1♂, NCSU), Rio Temas July 1937 [?light trap], A. J. White (2♂, NCSU). PUERTO RICO: Aguirre [as Acquirre], VIII-3-1948, J. S. Caldwell (1♂, USNM); Ponce, VI-29-1948, J. S. Caldwell (1♂, USNM). DOMINICAN REPUBLIC: Humachon Prov., Rio Nigua, Trujillo, Dec. 1955, J. Maldonado Capriles (1♂, USNM).

Nilaparvata gerhardi (Metcalf, 1923) New Combination

Figure 4

Liburnia gerhardi Metcalf, 1923: 210, pls. 62 and 70.

Euidella gerhardi (Metcalf): Metcalf, 1949: 58, pls. 1 and 4.

Euides gerhardi (Metcalf): Metcalf, 1952: 230-231.

Type material examined. “Beverly H’s/VIII:31:07 Ill // Col. by / WJGerhard // At light // Holotype / Euides / gerhardi / Metc [red paper]// Liburnia / gerhardi / Metc. / det. Z. P. M. [tan paper] // on indefinite loan / from N. Carolina / St. Univ. Raleigh” (♂ USNM).

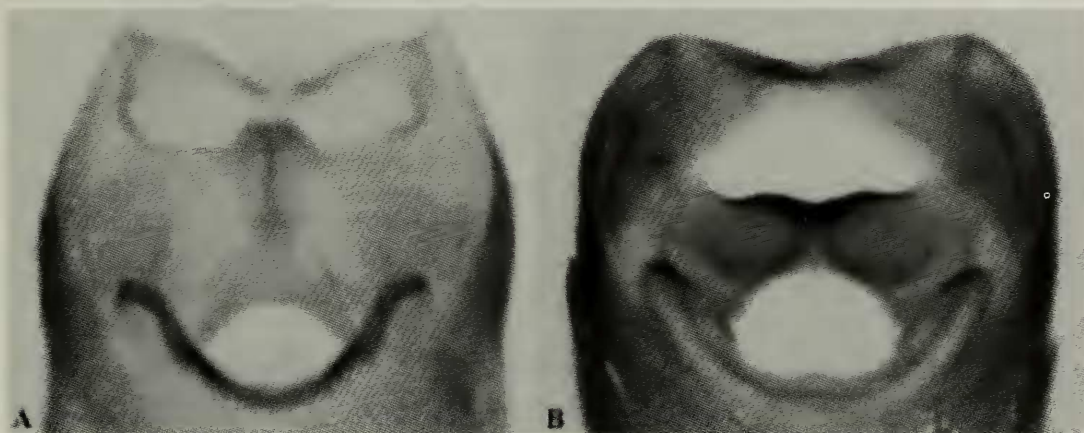


Figure 3. Genital diaphragms: A. *Nilaparvata caldwelli* (Belize), B. *Nilaparvata serrata* (Cayman Islands).

Diagnosis. Length ♂: 4.45 (4.30-4.60), ♀: 5.05 (4.45-5.40). This species closely resembles *N. wolcotti*, although it differs by the processes on segment X (longer and curved) and the shape of the parameres (dorsal margin subtruncate, lateral apex directed sublaterally). The parameres of both species are broad with a bluntly triangular, irregularly toothed basal angle, and a long, straplike dorso-medially directed inner angle, which in widest view appears to originate behind a broadly expanded outer angle. In *N. gerhardi*, the dorsal margin of the outer angle is subtruncate, having a two-stepped appearance, with the apex of the outer angle laterally directed. The aedeagus is terete with a large lateral flange on the

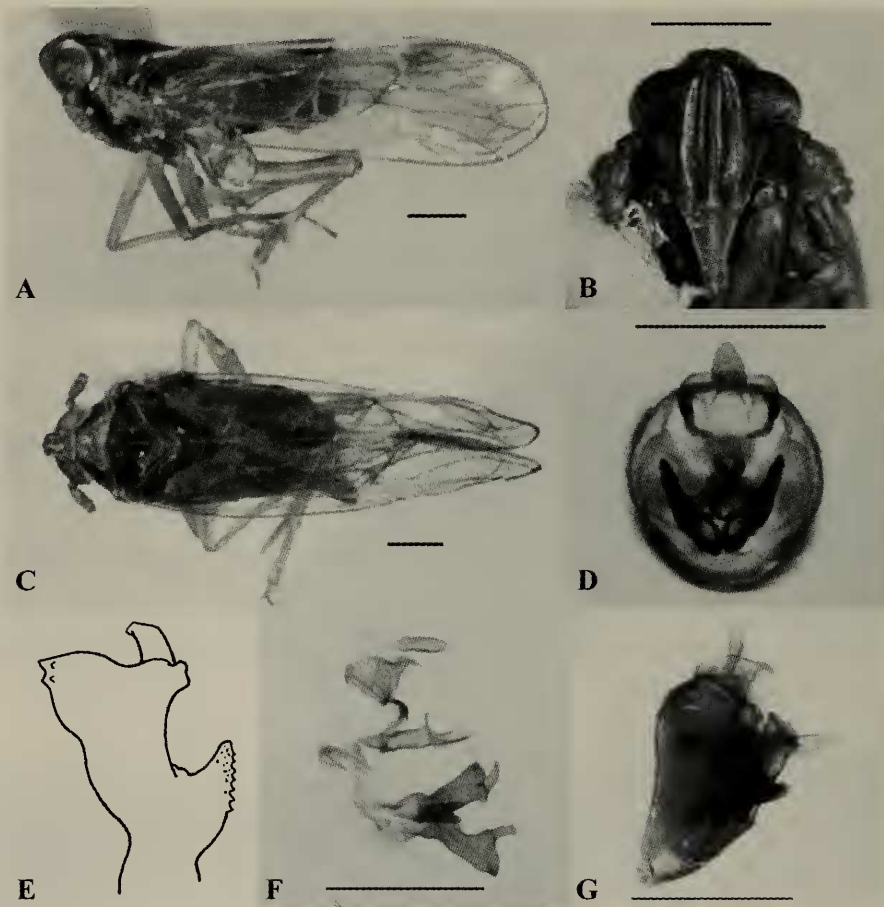


Figure 4. *Nilaparvata gerhardi*: A. lateral view, B. frons, C. dorsal view, D. pygofer, caudal view, E. left paramere, widest view, F. aedeagal complex with parameres and post genital segments, and G. pygofer, lateral view.

right side. In *N. gerhardi*, as in *N. wolcottii*, the proximal margin of the flange is strongly directed dorsad and conspicuous in left lateral view. The genital diaphragm is poorly developed (similar to Fig. 3B), bearing a slight, flattened, posteriorly directed armature. Dorsal margin of pygofer narrowed, segment X about 3/4 width of dorsal margin (Fig. 4D, vs. *N. wolcottii*). Segment X bears a pair short curved processes originating from the dorsolateral margins. In color, this species is similar to *N. wolcottii*, but less distinctly marked: brown to dark brown, with a paler vertex and prothorax, with a variably developed mesonotal vitta. Facial carinae slightly paler than frons. Wings mostly clear, with a melanistic spot at the apex of the claval suture. Females paler than males.

Remarks. This appears to be the most northerly distributed of the *Nilaparvata* species and it is likely that, based on both color and geographic indications, the Wisconsin and New York records among the undetermined females belong to this species.

The genitalia of the holotype are embedded in balsam within a gelatin capsule. The genitalia appear to match those described by Metcalf (1923, 1949); however,

the associated specimen on the point is not a *Nilaparvata*. Female specimens, cited below, with identical locality information as the holotype closely match Metcalf's description, suggesting that the type specimen was lost and the wrong specimen later applied to the point. The specimen on the point is of similar appearance to *Delphacodes andromeda* (Metcalf), and may in fact be the type specimen of *Delphacodes xerosa* Caldwell, which is missing from its point although its genitalia are present in a microvial. Since the holotype male genitalia match the original description, further nomenclatural changes are not needed.

Distribution. USA: Illinois, Louisiana, New Hampshire, New Jersey, North Carolina, Virginia; and apparently Guatemala.

Specimens Examined. NEW HAMPSHIRE: Hills Co., 3 Mi SE Brookline, Nissitissit River, VIII-17-1995, UV Light, D. S. Chandler (1♂, DENH), same, VII-27-1995 (1♀, DENH). NEW JERSEY: Seabrook, 7/27/[19]65, B/L Ser. X (1♂, USNM). ILLINOIS: Beverly H's, VIII-31-[19]07, W J Gerhard, at light (2♀, USNM). VIRGINIA: Chantilly, 8/25/[19]64 (2♂, 1♀ all on same point, plus 1♂, USNM). NORTH CAROLINA: Cabarrus Co., Coddle Creek Reservoir, (VI-VII)-1995, NJ Light Trap, B. A. Harrison (4♂, UDCC); same VIII-1995 (2♂, UDCC), same IX-1995 (1♂, UDCC). LOUISIANA: Iberville Par., St. Gabriel, 29-IX-1990, J. Zhou (1♂, LSUC). Tentatively included: GUATEMALA: specific locality not given, Feb. 1934 (1♂, USNM).

Nilaparvata serrata Caldwell, 1951

Figures 3B, 5

Nilaparvata serrata Caldwell, 1951 (in Caldwell and Martorell 1951): 192-4.

Type material examined. "RPiedrasPR / 12-31-47 / JSCaldwell // *Nilaparvata* / holotype / serrata [red paper]// JSCaldwell / Collection / 1959 // *Nilaparvata* ♂/ serrata Holotype/ Caldwell '49" (♂ and ♂ paratype, USNM).

Diagnosis. Length ♂: 3.75 (3.50-4.00), ♀: 4.33 (4.25-4.50). This species is most easily recognized by the broad parameres with a relatively short thick process at the basal angle, a larger thumblike, irregularly toothed inner angle; and a broad, flattened, outer angle with a nearly truncate lateral margin, often bearing a few small teeth. A minute tooth is usually present on the ventrocaudal margin of the base of the inner angle. Aedeagus terete, somewhat enlarged preapically, with a large but variably developed serrate flange on the right side. This flange is present in both *N. wolcotti* and *N. gerhardi*, but in both these species the proximal margin of the flange is strongly directed dorsad, and conspicuous in left lateral view; whereas in *N. serrata*, this flange is less produced and inconspicuous in left lateral view. The genital diaphragm is poorly developed (Fig. 3B), bearing a slight, flattened, posteriorly directed armature. Segment X bears a pair of strongly developed, ventrally hooked processes from its midlateral margins, which are strongly medially, then laterally curved. In color, this species is dark brown with a paler prothorax, vertex and often mesonotal carinae. Carinae on

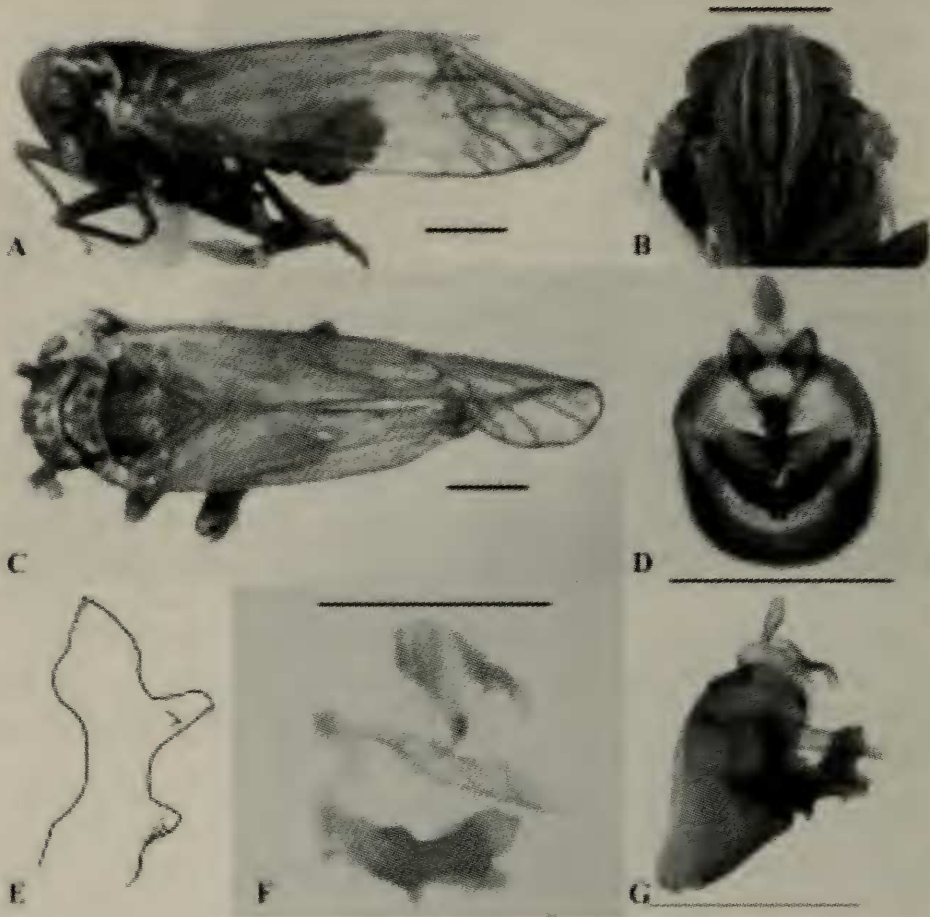


Figure 5. *Nilaparvata serrata*: A. lateral view, B. frons, C. dorsal view, D. pygofer, caudal view, E. left paramere, widest view, F. aedeagal complex with parameres and post genital segments, and G. pygofer, lateral view (scale bar = 0.5 mm).

frons conspicuously paler than frons. Wings somewhat infuscate, with little suggestion of the darkened area at the end of the claval suture. Females tend to be paler than males.

Remarks. One specimen, from Florida, was collected from "rice & grasses," suggesting habitat, if not host, for this species. The Bolivian specimen differs in subtle ways from the other specimens, most significantly by having the processes on segment X more closely approximated at the base, and by being overall much paler than *N. serrata* is generally.

Distribution. USA: Florida; Mexico, Belize, Costa Rica, Puerto Rico, Cayman Islands, and apparently Bolivia. Also reported from Nicaragua (Maes and O'Brien, 1988).

Specimens Examined. USA: FLORIDA: Belle Glade, Rabbit Is., 15-IX-1957 [J. Kramer], rice & grasses (1♂, USNM). MEXICO: Oax., 13 mi SE Oaxaca, 5180', VI-2-1974; C.W. & L. O'Brien & Marshall (1♂, LOBC); Ver., 27mi NW Veracruz, 300', Dec. 26, 1963, L. & C. W. O'Brien (1♂, LOBC); Mexico City

Area (MB-151), 1940's, D. M. De Long (2♂, UKYC); Chiapas, 5 mi S San Carlos, III-6-1953, at light, R. C. Bechtel, E. I. Schlinger (10♂, 11♀, EMEC). BELIZE (as British Honduras): Punta Gorda, May 1930 [? Light trap], J. J. White (2♂, NCSU); Rio Grande, June 1932 [? Light trap], J. J. White (1♂, NCSU); Cayo District, Esperanza, 12.4.1967, at light, D. J. McGr [? illegible] (1♂, BMNH). COSTA RICA: Heredia, nr Puerto Viejo, La Selva Biological Station., 10°25'N 84°00'W, 179 ft, Station Grounds, (18-19)-VIII-2003, C. R. Bartlett, J. Cryan, J. Urban (3♂, UDCC); same 15-VIII-2003 (1♂, 1♀, INBC); same 25-II-2004, C. R. Bartlett, (2♂, UDCC); La Selva, (22-24)-I-2000, A. E. Short (1♂, UDCC); Guanacaste, Estacion Experimental Enrique Jimenea Nunez, VI/15/[19]92; F. Parker (2♂, 1♀, UKYC). CAYMAN ISLANDS: Cayman Brac, The Creek, 18-XI-1995, UV Light, C. R. Dilbert (2♂, 6♀, FSCA); same, 22-XI-1995 (1♀, FSCA); same, 28-XI-1995 (2♂, 2♀, FSCA); same, 6-XII-1995 (3♂, 3♀, FSCA); same, 8-XII-1995 (1?, FSCA); same, 15-XII-1995 (9♂, 3♀, FSCA); same, 23-XII-1995 (2♂, 2♀, FSCA); same, 27-XII-1995 (5♂, 1♀, FSCA). Tentatively included: BOLIVIA: Santa Cruz, 10 mi. W. Portachuelo, March 26, 1978, UV Light, C. W. O'Brien (1♂, LOBC).

Nilaparvata wolcotti Muir and Giffard, 1924.

Figures 6, 7

Nilaparvata wolcotti Muir and Giffard, 1924: 17, 51.

Type material examined. "Barceloneta, P.R. / April 9, 1920 // G. N. Wolcott, / Collector. // on cane // Paratype [yellow paper] / Muir Coll. / Brit. Mus.1932-279." (1 male, missing from point, male terminalia and abdomen mounted in balsam between cover slides on card stock with annotation "Nilaparvata / wolcotti / ♂m.g." [handwritten]). "Pt. Cangrejos, P.R. / March 12, 1920. // G. N. Wolcott, / Collector." (BMNH, missing abdomen.)

Diagnosis: Length macropter ♂: 4.81 (4.50-5.20), ♀: 4.89 (4.75-5.00); brachypter ♂: 2.68 (2.50-2.85), ♀: 3.16 (2.10-3.25). This species closely resembles *N. gerhardi* in many respects, but is most readily separated by the processes on segment X (very short) and the shape of the parameres (dorsal margin gradually sloped to a dorsolaterally directed apex). The parameres of both species are broad with a bluntly triangular, irregularly toothed basal angle, and a long, strap-like, dorsomedially directed inner angle, which in widest view appears to originate behind a broadly expanded outer angle. In *N. wolcotti*, the dorsal margin of the outer angle is inclined to an acute, dorsolaterally directed apex, compared to a more truncate, two-stepped appearance of *N. gerhardi*, terminating in a more laterally directed apex. The aedeagus is terete and somewhat enlarged preapically, with a large lateral flange on the right side. In both *N. wolcotti* and *N. ger-*

hardi, the proximal margin of the flange is strongly directed dorsad and conspicuous in left lateral view. The genital diaphragm is poorly developed (similar to Fig. 3B), bearing a slight, flattened, posteriorly directed armature. Dorsal margin of pygofer wide, segment X about 3/5 width of dorsal margin (Fig. 6D, vs. *N. gerhardi*). Segment X bears a pair of variably developed teeth originating somewhat lateroventrad from the dorsolateral margins. In color, macropters of this species are brown to dark brown, with a conspicuously paler vertex and prothorax, with a variably developed but conspicuous mesonotal vitta. Facial carinae paler than frons. Wings mostly clear, with a well-developed melanistic spot at the end of the claval suture. Females tend to be paler than males with the median vitta of the mesothorax less distinct.

Remarks. The specimen collected in the Gulf of Mexico was found approximately 46 km from the Louisiana coast. The specimen from California cited in undetermined females appears to be this species. This is the only species for which brachypterous specimens were located. Most of the brachypterous specimens (22 of 25), were from a single series from Plain City, Utah, which also included a single nymph. Reported on sugarcane (*Saccharum officinarum* L., Muir and Giffard 1924) and malojillo grass (*Panicum molle* Swartz, Wolcott 1936).

This species was “[d]escribed from one male and one female (types) from Pt. Congrejos [sic - Cangrejos], Porto Rico (G. N. Wolcott, February, 1920) and one male from Barceloneta, Porto Rico (G. N. Wolcott, April 1920), on sugar cane” (Muir and Giffard 1924: 17). The specimens provided from BMNH consists of the Barceloneta specimen, labeled as a paratype, and a specimen from Pt. Cangrejos, P.R. missing the abdomen, collected March 12, 1920. The specimens reported by Muir and Giffard (1924), evidently were collected March 3, 1920 (♂) and March 20, 1920 (♀) (not February), and both these specimens are missing their abdomen (M. Webb, BPBM, pers. comm.) (requested on loan, not available). Since the Barceloneta male was clearly in Muir and Giffard’s (1924) type series and bears the diagnostic features of the male genitalia; and because Muir and Giffard (1924) did not specify which specimen was the holotype, I have treated the Barceloneta male as the primary type with respect to maintaining a stable species concept.

Distribution. USA: Arizona, California, Colorado, Delaware, Florida, Maryland, New Jersey, Utah; Mexico; Puerto Rico.

Specimens Examined. USA: NEW JERSEY: Seabrook, 7/27/65, B/L Ser. X, B200 (1♂, USNM). DELAWARE, New Castle Co., Middletown, Brick Mill Farm, 522 St. Michael Dr., 07-VI-2004, A. Gonzon, Collected at porch light (2♂, UDCC); same 29-VIII-2003 (1♂, UDCC); Sussex Co., Nanticoke WMA, Phillips Landing, 12-VII-2005, A. Gonzon, Hg Vapor Light, xeric sand ridges (4♂, 2♀ UDCC). MARYLAND: Crisfield, 8-5-32, F. C. Bishop, Mosq. Trap (3♂, USNM); Chestertown, 6-29-32, F. C. Bishop, Mosq. Trap (1♂, USNM). COLORADO: Ft. Collins, 9 10 [19]01 (1♂ [missing from point, genitalia in mi-

crovial], 1♀brachypter, USNM). UTAH: Utah Co., Goshen Ponds, SW of Santaquin, 15-VII-2000, J. A. Robertson (UDCC, 1♂, 1♀); Utah Co., Provo, BYU, 18-VII-2000, I. S. Winkler, at light (1♂, 1♀, UDCC); Richfield, July 15, 1930, Light Trap (4♂, 2♀, USNM); Farmington, 8-19-1936, G. F. Knowlton (1♂, USNM); Plain City, 8-5-[19]03 (6♂, 16♀, 1 broken, 1 nymph; all brachypterous; USNM). FLORIDA: Palm Beach Co., Boyton Beach, Nautica Sound, Sept. 3, 1999, Black Light, V. Golia (1♂, VGC); Palm Beach Co., Lake Worth, Geneva Lakes Court, October 28, 2004, V. Golia, Mercury Vapor Light (1♀, VGC); same, October 27, 2004 (1V, VGC); same, May 24, 2003, Black Light (1♂, VGC); Broward Co., Ft. Lauderdale, 4 June 1974, Rotary Net, N. L. Woodiel (1♂, USNM); Broward Co., Hwy 27, Sawgrass Rec Area, 23 mi NW Ft.

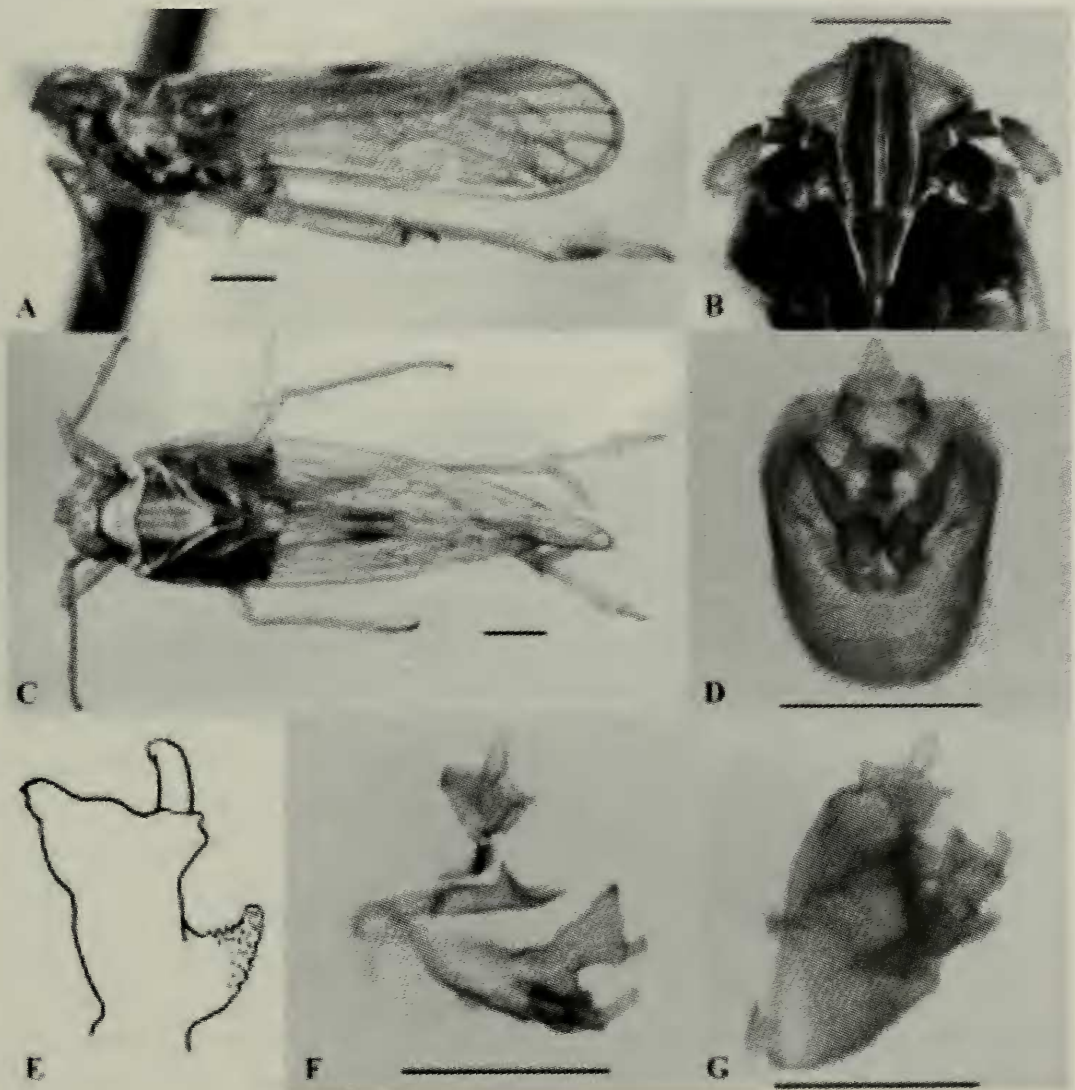


Figure 6. *Nilaparvata wolcottii* macropter: A. lateral view, B. frons, C. dorsal view, D. pygofer, caudal view, E. left paramere, widest view, F. aedeagal complex with parameres and post genital segments, and G. pygofer, lateral view.

Lauderdale, 21-V-1976, UV Trap, C. W. O'Brien & G. B. Marshall (1♂, 2♀, LOBC); Collier Co., Collier-Seminole S.P., 22-VI-1965, C. W. O'Brien, Blacklight trap (1♂, LOBC); Palm Beach Co., Lake Worth Geneva Lakes Court, 8-VIII-2003, V. Golia, Mercury Vapor Light (1♂, VGC). ARIZONA: Sabino Canyon, July 9, 1952 [R. H. Beamer] (1♂, SEMC); Chiric. Mts. 9-11-35, E. D. Ball (1♂, USNM). CALIFORNIA: San Joaquin Co., 24 Aug 1974, It Trap, M. Croce, 75-6719 (1♂, USNM); Sacramento, VIII-14-1934 (1♂, USNM); Sacramento, VIII-12-1933, H. H. Keifer (1♂, CSCA); Palm Canon, Palm Springs, 17 Dec[19]'17, J. Ch. Bradley (2♂ Brachypter, USNM); Siskiyou Co., 5 mi N of Gazelle, (7-3)-(8-10), 1981, Light Trap, John Hunter Orchard, F. D. Horn (1♂, CSCA); Santa Barbara Co., Santa Cruz Is., 17-VIII-1939, L. M. Martin (1♂, 1♀, CSCA). GULF OF MEXICO, 29°35'N, 93°20'W, 12-VIII-1984, M. L. Isreal, blacklight trap (1♂, USNM). MEXICO: Salvatierra, 7 mi. W., Guanajuato, VII-28-1954, E. I. Schlinger (1♂, EMEC). PUERTO RICO: Bayamon, Anderson & Lesene, San Juan No. 2983, on grass (1♀, 1 broken, USNM, tentatively included).

Undetermined *Nilaparvata* females

USA: WISCONSIN: Kenosha Co., August 2[6?], 1953, D. H. Habeck (1♀, NCSU). NEW YORK: Westchester County, Greenburgh, Route 9A, July 10, 1994, V. Golia, Black light (1♀, VGC); Rochester, USGC, 5 July 1968 (1♀, NYSM). CONNECTICUT: Prospect, VII-22-2001, C. W. O'Brien, at night (1♀, LOBC). MARYLAND, Allegany Co., Little Orleans, 13-VII-2000, S. T. Dash, sweeping meadow (1♀, UDCC). FLORIDA: Collier County, Fakahatchee Strand St. Res. K-12, 18-V-1998, C. W. O'Brien (1♀, LOBC); Green Cove Springs, Aug. 1942, R C Barnes, at light trap (2♀, USNM); Palm Beach Co., Delray Beach, Country Lake, March 19, 1994, V. Golia, Mercury Vapor Light (1♀, VGC); same except October 25, 1994 (1♀, VGC). CALIFORNIA: Contra Costa Co., Antioch Natl. Wildlife Ref. (SF), X-10-1991, blacklight, J. Powell (1♀, EMEC). BELIZE (as British Honduras): Punta Gorda, May 1930, J. J. White (10♀, NCSU); Rio Grande, June 1932, J. J. White (3♀, NCSU); Rio Temas, July 19[27?], A. J. White (1♀, NCSU); (as Belize) Belize district, Western Highway nr Belize Zoo, 7-Jan.-2003, C. R. Bartlett, Pine Grassland (1♀, UDCC); Cayo District nr Teakettle Bank, nr Pook's Hill, 8-Jan.-2003, C. R. Bartlett, Sweep at river (1♀, UDCC). COSTA RICA: Heredia, Estac. Biol. La Selva, 50-100m, I-8/17-1993, blacklight in secondary forest, J. Powell (1♀, EMEC). GUATEMALA: Morales, Oct 1930, J. J. White (1♀, NCSU); Guatemala City, 3/29/1953, D. M. Delong (1♀, UKYC). PANAMA: Chiriqui Prov., Vagala, 10 km NW of David, (8-15)-Jan.-1981, A. C. Brown, Malaise Trap nr. Rice and River (1♀, NCSU). PARAGUAY: Cordillera, Inst. Agro. Nac. Caacupe, Jan. 17-20, 1983. E. G. Riley (1♀, LSUC). CUBA: XI-26-1935, Baltimore no 3903 (1♀, USNM).

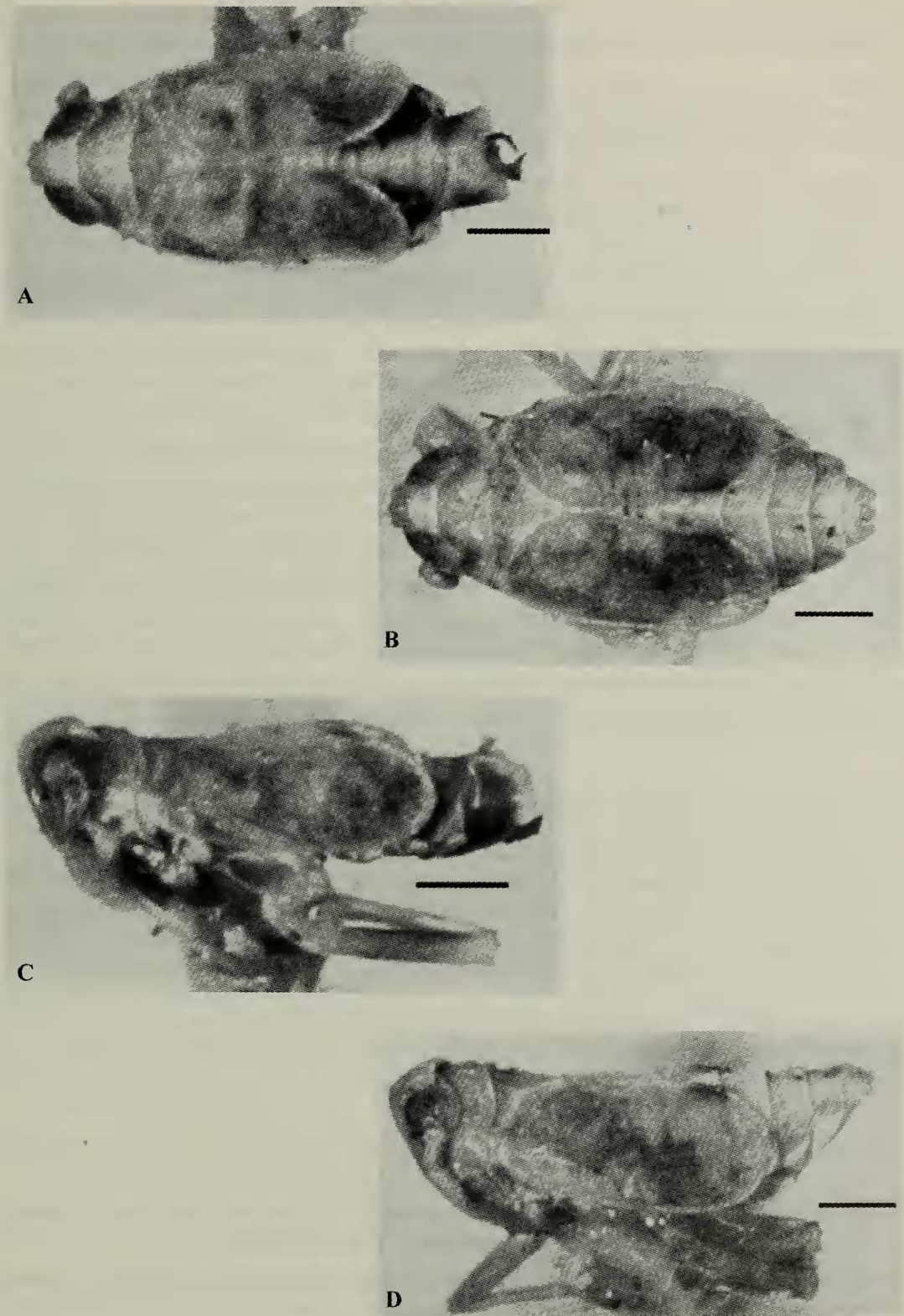


Figure 7. *Nilaparvata wolcotti* brachypters (Utah): A. dorsal view, male. B. dorsal view, female; C. lateral view, male; D. lateral view, female.

DISCUSSION

Nilaparvata serrata, *N. caldwelli*, and *N. wolcottii* were found to occur well outside of their previously reported range. It is puzzling that the genus has gone largely unrecognized outside of Puerto Rico since it is relatively easy to recognize. It might be possible that the Puerto Rican species were introduced to the continental fauna, but the high dispersal ability known in this genus makes endemicity or adventive dispersal more plausible hypotheses. Most observed specimens were macropterous (191 of 216 specimens), with brachypters only found for *N. wolcottii*. Nearly all specimens with collecting methods recorded were collected at lights, except one specimen from Panama collected at a malaise trap, and two specimens collected by sweeping. Unfortunately, light collecting provides little information concerning hosts or habitat, although two specimens (one *N. serrata* from Florida and one undetermined female from Panama) indicated that they were collected near rice, a habitat consistent with the rice and *Leersia* hosts known for Old World *Nilaparvata* species. *Nilaparvata wolcottii*, however, was found well outside the range of either of its reported hosts. The widespread occurrence of these species and the record of a *Nilaparvata* in the Gulf of Mexico may suggest that the New World *Nilaparvata* species are migratory in a similar manner to *Nilaparvata lugens* (e.g., Taylor 1985, Kisimoto 1991, Watanabe 1995), although perhaps less dramatically. It is anticipated that all of these *Nilaparvata* species will be found to be even more widely distributed than is reported here.

ACKNOWLEDGMENTS

I am grateful to Anthony Gonzon and Martin Spellman for their assistance in digital photography, and Meg Ballard for assistance in digital image management. Kimberly Shropshire graciously provided the line art of the parameres. I would like to thank William Brown for assistance in mapping the collecting location of the Gulf of Mexico specimen, and for his helpful suggestions on drafts of this manuscript. I am particularly grateful to Marion Zuefle for her assistance with German text. For specimens, I would particularly like to thank Vince Golia for his collecting enthusiasm, Tim McCabe and Jason Cryan for (re)locating the NYSM specimen. This research was supported by NSF Systematic Biology Program award DEB-0342538 and the University of Delaware Department of Entomology and Wildlife Ecology.

LITERATURE CITED

- Arnett, R. H., Jr., G. A. Samuelson, and G. M. Nishida. 1993. The Insect and Spider Collections of the World, 2nd ed. Sandhill Crane Press, Gainesville, Florida. 310 pp.
- Asche, M. 1985. Zur Phylogenie der Delphacidae Leach, 1815 (Homoptera: Cicadina: Fulgoro-morpha). Marburger Entomologische Publikationen 2(1), volume 1 pp. 1-398, volume 2 pp. 399-910.
- Bartlett, C. R. and L. L. Deitz. 2000. Revision of the New World delphacid planthopper genus *Pissonotus* (Hemiptera: Fulgoroidea). Thomas Say Publications in Entomology: Monographs. 234 pp.

- Caldwell, J. S. and L. F. Martorell.** 1951 [dated 1950]. Review of the Auchenorynchous [sic] Homoptera of Puerto Rico. Part II. The Fulgoroidea except Kinnaridae. *Journal of Agriculture of the University of Puerto Rico* 34(2): 133-269.
- China, W. E.** 1925. The Hemiptera collected by Prof. J. W. Gregory's expedition to Yunnan, with synonymic notes on allied species. *Annals and Magazine of Natural History, London* 9(16): 449-485.
- Claridge, M. F. and M. R. Wilson.** 1982. The leafhopper and planthopper fauna of rice fields in south east Asia. *Acta Entomologica Fennica* 38: 21-22.
- Claridge, M. F. and J. C. Morgan.** 1987. The Brown Planthopper, *Nilaparvata lugens* (Stål), and some related species: A biotaxonomic approach. pp. 19-32. In: M. R. Wilson and L. R. Nault (Editors). *Proceedings of the Second International Workshop on Leafhoppers and Planthoppers of Economic Importance*. Brigham Young University, Provo, Utah, USA, 28th July-1st August 1986. CAB International Institute of Entomology, London. xiii + 368 pp.
- Distant, W. L.** 1906. Rhynchota. The fauna of British India, including Ceylon and Burma. No. 3. Taylor and Francis, London, England. 266 pp.
- Fennah, R. G.** 1961. Le Parc National de Niokolo-Koba. XXXIII. Homoptera Fulgoroidea. *Mémoires de l'institute Francaises de l'Afrique Noire* 62: 305-320.
- Guo, L-Z., A-P. Liang, and G-M. Jiang.** 2005. Four new species and a new record of Delphacidae (Hemiptera) from China. *Oriental Insects* 39: 161-174.
- Hill, D. S.** 1983. *Agricultural Insect Pests of the Tropics and Their Control*. Second Edition. Cambridge University Press, New York, NY, U.S.A. xii + 746 pp.
- Kisimoto, R.** 1991. Long-distance migration of rice insects. Pp. 167-195. In: E. A. Heinrichs and T. A. Miller (eds.). *Rice Insects: Management Strategies*. Springer-Verlag, New York, NY, U.S.A. xiii + 347 pp.
- Linnavuori, R.** 1973. Hemiptera of the Sudan, with remarks on some species of the adjacent countries 2. Homoptera Auchenorrhyncha: Cicadidae, Cercopidae, Machaerotidae, Membracidae and Fulgoridae (Zoological contribution to the Sudan no. 33). *Notulae Entomologicae* 53(3): 65-137.
- Maes, J. M. and L. B. O'Brien.** 1988. Catálogo de los Fulgoroidea (Homoptera) de Nicaragua. *Revista Nicaraguense de Entomología* 2: 27-42.
- Metcalf, Z. P.** 1923. A Key to the Fulgoridae of Eastern North America with descriptions of new species. *Journal Of the Elisha Mitchell Scientific Society* 38(3): 139-230, plus 32 plates.
- Metcalf, Z. P.** 1949. The redescription of twenty-one species of Areopidae described in 1923. *Journal of the Elisha Mitchell Scientific Society* 65(1): 48-60 plus, 4 plates.
- Metcalf, Z. P.** 1952. New names in the Homoptera. *Journal of the Washington Academy of Sciences* 42(7): 226-231.
- Metcalf, Z. P.** 1955. Entomology – New names in the Homoptera. *Journal of the Washington Academy of Sciences* 45(8): 262-267.
- Muir, F. A. G. and W. M. Giffard.** 1924. Studies in North American Delphacidae. Experiment Station of the Hawaiian Sugar Planters' Association, Entomological Series, Bulletin 15: 1-53.
- Nast, J.** 1984. Notes on some Auchenorrhyncha (Homoptera), 1-5. *Annales Zoologici (Warsaw)* 37(15): 391-398.
- Sogawa, K. and D. Kilin.** 1984. Possible genetic isolation between the *Leersia* and rice brown planthopper. *International Rice Research Newsletter* 9(6): 15.
- Sogawa, K., D. Kilin, and A. Kusmayadi.** 1984. A *Leersia*-feeding brown planthopper (BPH) biotype in north Sumatra, Indonesia. *International Rice Research Newsletter* 9(3): 20.

- Stål, C.** 1854. Nya Hemiptera. Ofversigt af Kongliga Svenska Vetenskaps-Akademiens Forhandlingar 11: 231-255.
- Suzuki, Y.** 2004. Historical development in research and management of long-distant migratory rice planthoppers. *Agrochemicals Japan* 85: 2-6.
- Taylor, R. A. J.** 1985. Migratory behavior in the Auchenorrhyncha. pp. 259-288. *In*, L. R. Nault and Rodriguez, J. G. (Editors). *The leafhoppers and planthoppers*. John Wiley & Sons, New York, NY, U.S.A. xvi + 500 pp.
- Watanabe, T.** 1995. Forecasting systems for migrant pests. 2. The rice planthoppers *Nilaparvata lugens* and *Sogatella furcifera* in Japan. pp. 365-376. *In*, V. A. Drake and A. G. Gatehouse (Editors). *Insect migration: tracking resources through space and time*. Cambridge University Press, New York, NY, U.S.A. i-xvii, 1-478 pp.
- Wilson, M. R. and M. F. Claridge.** 1985. The leafhopper and planthopper faunas of rice fields. pp. 381-404. *In*, L. R. Nault and J. G. Rodriguez (Editors). *The Leafhoppers and Planthoppers*. John Wiley & Sons, New York, NY, U.S.A. xvi + 500 pp.
- Wilson, M. R. and M. F. Claridge.** 1991. *Handbook for the Identification of Leafhoppers and Planthoppers of Rice*. C.A.B. International, Wallingford, Oxon, U.K. x + 142 pp.
- Wilson, S. W. and L. B. O'Brien.** 1987. A survey of planthopper pests of economically important plants (Homoptera: Fulgoroidea). pp. 343-360. *In*, M. R. Wilson and L. R. Nault (Editors). *Proceedings of the 2nd International Workshop on Leafhoppers and Planthoppers of Economic Importance: Brigham Young University, Provo, Utah, USA, 28th July-1st August 1986*. CAB International Institute of Entomology, London, England, U.K. xiii + 368 pp.
- Wilson, S. W., C. Mitter, R. F. Denno, and M. R. Wilson.** 1994. Evolutionary patterns of host plant use by delphacid planthoppers and their relatives. pp. 7-45. *In*, R. F. Denno and T. J. Perfect (eds.). *Planthoppers: Their Ecology and Management*. Chapman & Hall, New York, NY, U.S.A. x + 799 pp.
- Wolcott, G. N.** 1936. "Insectae Borinquenses." A revision of "Insectae Portoricensis." *Journal of Agriculture of the University of Puerto Rico* 20(1):1-600.